

## Spotted Knapweed Seed Destruction by Seedhead Attacking Insects

D. M. Woods, D. B. Joley, and V. Popescu

Five seedhead-feeding biological control agents are currently established on spotted knapweed, *Centaurea maculosa* Lamarck (Asteraceae), in California. Three of these, *Urophora affinis* Frauenfield (Diptera: Tephritidae), *Terellia virens* (Loew) (Diptera: Tephritidae), and *Larinus minutus* Gyllenhal (Coleoptera: Curculionidae), were intentionally released whereas *Urophora quadrifasciata* (Meigen) (Diptera: Tephritidae) migrated from knapweeds in Oregon and *Eustenopus villosus* (Boheman) (Coleoptera: Curculionidae) spread from yellow starthistle. Since one of the impacts of each of these insects is believed to be the direct destruction or displacement of seeds within the seedhead, we conducted a seed destruction study from 1998 to 2002 at study areas along the Pit River in Shasta County. Individual seedheads with oxidized flowers were enclosed in cotton bags every other week during the flowering season over the five-year period (approximately 50 bagged heads per bagging date per year). At the end of the season, the bagged, mature seedheads were dissected and inspected for viable seed as well as evidence of attack by the seedhead insects. Three sites were evaluated along a two-mile stretch of the river. The hill and plot sites were chosen because insects were intentionally released there while the Log Jam site was chosen as the result of natural movement of the insects, principally the two fly species leaving the slower moving weevils behind.

Seed production and impact of individual insect species are shown in Table 1. Seed production for the clean seedheads (no insects) was fairly consistent from year to year at each individual site. Variation from site to site is likely due to plant age structure and soil type. The Log Jam site consists of relatively young, three to four year old vigorous plants, compared to the older plants populating the other sites. Both the plot and the Log Jam sites are rock and sand soils with no shade, while the hill site is partially shady with sandy soil. Neither of the two *Urophora* gall flies produced dramatic impacts by themselves, in spite of occasionally producing as many as seven to nine galls in a seedhead. Results with *Terellia virens*, which were detailed in last year's annual report, were also equally disappointing because the species caused very little seed destruction. The yellow starthistle hairy weevil, *E. villosus*, had an enormous effect in the few instances when it was present. Heads that *E. villosus* oviposited in produced virtually no seed at all. The hairy weevil, however, greatly prefers yellow starthistle to spotted knapweed. In fact, the only substantial attack on spotted knapweed occurred when early season drought compelled a large population of hairy weevils to leave the shriveled prebloom yellow starthistle and moved to a second quality host. The weevil, *Larinus minutus*, has consistently been the major impact on spotted knapweed at our sites, destroying 60 to 90% of the seeds compared to numbers in clean seedheads.

Many of the seedheads were attacked by more than one agent and these seedheads are included only in the site total for each year, not under individual agents. The most common combinations were one or more of the gall flies along with *Larinus minutus*. Galls were usually partially to completely destroyed in these co-infestation cases. It is interesting, however, that both species of gall fly could coexist within a single seedhead.

Table 1. Seed production of spotted knapweed at three sites along the Pit River in Shasta County. Values are mean seed per seedhead. Superscripts represent the number of samples when the sample size is very small (n=one to three). The dashed values indicate that no collected sample met the criteria.

<b>Hill</b>	1998	1999	2000	2001	2002
No insects	15.7	14.6	16.0	15.5	10.7
<i>Larinus minutus</i> only	0.4	2.8	3.1	5.5	0.9
<i>Eustenopus villosus</i> only	-	0.5	1.7	7 <sup>2</sup>	-
<i>Urophora affinis</i> only	17.2	9.5	13.4	11.1	2.0 <sup>3</sup>
<i>Urophora quadrifasciata</i> only	12.3	11.7	10.6	11.3	-
<i>Terellia virens</i> only	-	-	-	18.5 <sup>2</sup>	-
Site total	11.3	5.9	5.8	8.7	1.4

  

<b>Plot</b>	1998	1999	2000	2001	2002
No insects	9.5	14.5	12.0	12.4	-
<i>Larinus minutus</i> only	3.2	1.6	1.7	4.2	1.7
<i>Eustenopus villosus</i> only	-	2.4	1.4	3.0 <sup>2</sup>	0 <sup>1</sup>
<i>Urophora affinis</i> only	8.6	2.4	6.1	5.2	4.0
<i>Urophora quadrifasciata</i> only	4.0	6.3	11.4	7.5	0 <sup>2</sup>
<i>Terellia virens</i> only	-	-	8.0 <sup>1</sup>	8.0 <sup>1</sup>	-
Site total	3.4	2.0	2.9	5.4	1.3

  

<b>Log Jam</b>	1998	1999	2000	2001	2002
No insects	-	-	-	17.6	17.8
<i>Larinus minutus</i> only	-	-	-	5.7 <sup>3</sup>	0 <sup>1</sup>
<i>Eustenopus villosus</i> only	-	-	-	-	-
<i>Urophora affinis</i> only	-	-	-	12.2	11.1
<i>Urophora quadrifasciata</i> only	-	-	-	11.5	9.6
<i>Terellia virens</i> only	-	-	-	11.9	9.0
Site total	-	-	-	13.8	8.0